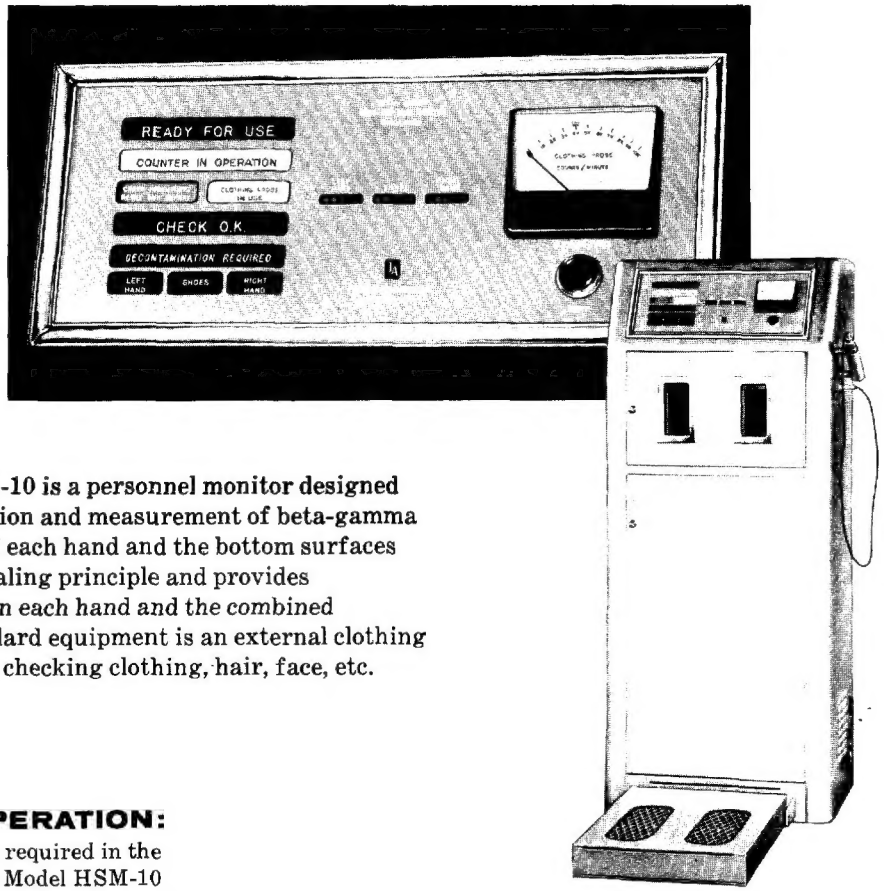
INSTRUMENTATION FOR NUCLEAR RESEARCH

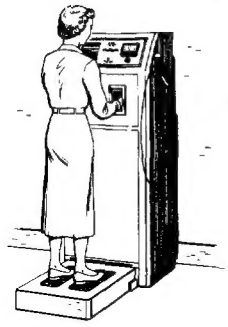
Beta-Gamma HAND and SHOE MONITOR

Model HSM-10

Completely automatic monitoring.
Safe, error-proof, and easy-to-use.
Wide range of warning levels.
Positive warning of incomplete check.
Includes external clothing probe.



DESCRIPTION: The Model HSM-10 is a personnel monitor designed to provide completely automatic detection and measurement of beta-gamma contamination on the back and palm of each hand and the bottom surfaces of both shoes. It employs the decade scaling principle and provides register read-outs for the total count on each hand and the combined count for both shoes. Included as standard equipment is an external clothing probe with 5-foot self-coiling cable for checking clothing, hair, face, etc.



OPERATION:

No skill is required in the operation of the Model HSM-10 Monitor. The user simply follows the instructions on the illuminated multi-colored panels at the top of the instrument.

When the monitor is ready for testing, the blue "READY FOR USE" panel will be illuminated. To start the operation, the user merely steps on the shoe deck and inserts hands into the two waist-high probe openings. The counting process is started and maintained by pressure of the finger-tips at the rear of the probe openings, and by the weight of the user on the shoe deck. As soon as the counting starts, the "READY FOR USE" panel darkens, and the yellow "COUNTER IN OPERATION" panel lights up.

NOTE: If at any time during the counting cycle, the user should remove either hand, or step off the shoe deck, the cycle will automatically stop, and the orange panel, reading "CHECK INCOMPLETE – RESET AND REPEAT," will be illuminated. This positive warning prevents erroneous readings.

After a short length of time – as preset by the mechanical timer – the "COUNTER IN OPERATION" panel darkens and either the green "CHECK O.K." panel or the red "DECONTAMINATION REQUIRED" panel lights up, depending upon whether the radioactivity present is above or below the preset maximum allowable level. The user then pushes the large red "RESET" pushbutton on the front panel, and the instrument is ready for the next user.

If the "DECONTAMINATION REQUIRED" panel lights up, one or more of the small red panels marked "LEFT HAND," "SHOES," or "RIGHT HAND" will also be illuminated, depending upon the location of the contamination. The degree of contamination can be checked by noting the register readings.

The clothing probe, which is located on the right side of the instrument cabinet, is actuated by a switch located just above the probe holder. When this is done, the white "CLOTHING PROBE IN USE" panel lights up. The output of the clothing probe is read on a count rate meter which is calibrated 0 to 10,000 counts per minute.

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5-DIGIT SODECO REGISTERS

MULTI-COLORED ILLUMINATED INSTRUCTION PANELS

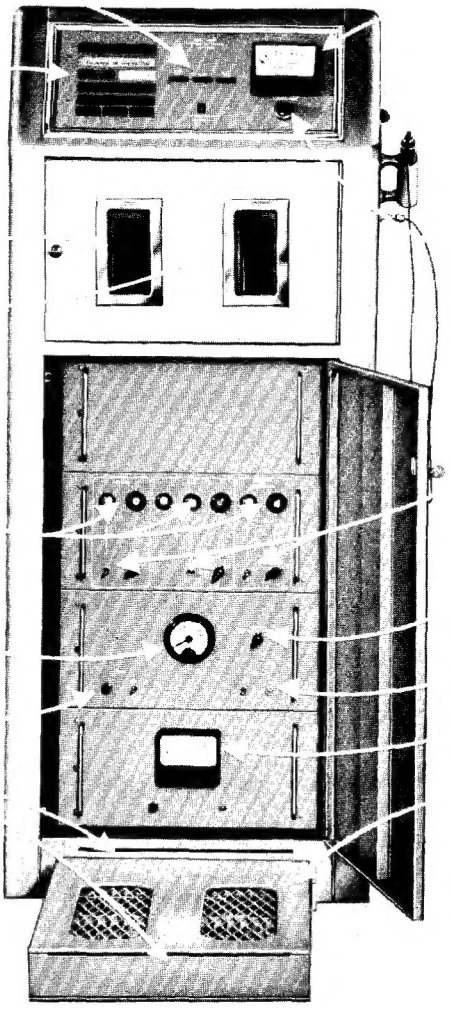
HAND PROBES

GLOW DECADE TUBES FOR SCALING CHANNELS

MECHANICAL TIMER

POWER ON/OFF

SLOTS FOR DISPOSABLE PROTECTIVE PAPER



CLOTHING PROBE RATE METER

SWITCH FOR CLOTHING PROBE

CLOTHING PROBE AND HOLDER

AUTOMATIC RESET PUSH-BUTTON

SWITCHES TO VARY THE SCALING FACTORS

SWITCH FOR BACKGROUND TEST AND 60-CYCLE TESTING

TIMER ON/OFF

HIGH VOLTAGE METER

SHOE DECK

FLEXIBILITY

The Model HSM-10 offers an unusually wide range of operating limits and warning levels, and thus can serve any health physics requirement. Use of three switches in each channel provides as many as 15 different scaling factors. Time intervals on the mechanical timer are variable from 1 to 120 seconds.

CONSTRUCTION: The Model HSM-10 is housed in a metal cabinet with a smooth grey hammertone finish. A door, with lock, covers all controls, protecting the instrument from misadjustment by unauthorized personnel. Adjustments, tube replacements, and routine servicing can be done without removing the chassis from the cabinet.

SPECIFICATIONS:

SENSITIVITY: Minimum Beta energy 0.2 MEV.

TUBES: T/A Type T1100 halogen-quenched.

ALARM SETTINGS: Hand Channels—100 to 10,000 counts in 15 steps. Shoe Channel—1000 to 100,000 counts in 15 steps.

COUNTING PERIOD: Variable from 1 to 120 seconds.

REGISTER RANGE: 0 to 99999, five digits on each of three Sodeco Registers.

WARNING LEVEL INDICATOR: Adjustable by the Health Physicist.

POWER SUPPLY REQUIRED: 300 watts, 95-125 volts 60 cycle A.C.

DIMENSIONS: Cabinet: 65" high x 27" wide x 18" deep. Foot Deck: 25" long x 18" wide x 4" high.

SHIPPING WEIGHT: 650 lbs.

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INSTRUMENTATION FOR NUCLEAR RESEARCH

BETA-GAMMA PERSONNEL and LAUNDRY MONITORS

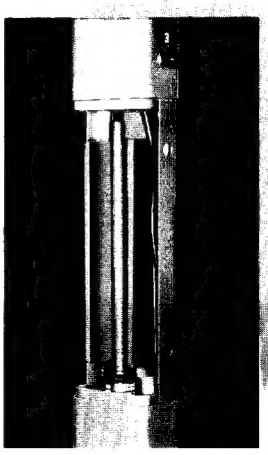
Model PPM-8 Portal Type • Model LIM-18 Laundry Type

- Alarm lights on portal and meter indicators on console panel provide double check on location of contamination.
- Lead shielding around individual detectors minimizes background.
- Watertight threshold with detachable plastic foot mat for easy decontamination.
- Audible (buzzer) and visual (red light) alarms.
- Eight separate counting rate circuit channels with individual alarm settings.
- Single button to reset all channels.
- Single H. V. power supply for all channels.
- Easy-to-service console cabinet.

APPLICATION: Model PPM-8 Portal Monitor provides a quick, efficient, economical method of "head to toe" monitoring of personnel entering or leaving an area. To prevent the spread of contamination, the Portal Monitor is placed at a control point so that personnel entering or leaving the controlled area pass through the portal. Should the contamination on any person passing through the portal exceed a preset radiation level, immediate detection and alarm will result.

OPERATION: No skill is required by personnel being monitored. As person passes through the portal, any detected change in the level of radiation at 8 different body areas is indicated on a corresponding meter. An audible alarm sounds when the preset radiation level is exceeded, and indicator lights on *both* portal and console panel glow "RED" to indicate the exact spots of contamination. The inside dimension of the portal is purposely narrow to prevent personnel from moving through too rapidly to complete a good check; however, passage can usually be made at 2-second intervals.

SEVEN DETECTORS are located around the sides and top of portal to check head, shoulders, waist, and legs; and four detectors are grouped in the threshold to check the soles and heels of shoes.



The insert at right shows the lead shielding behind each individual detector (T/A #1120 Tube) in portal. This shielding minimizes the background count.

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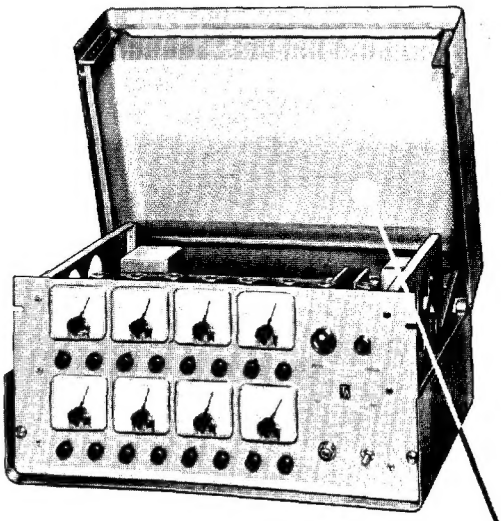


PECIFICATIONS

of PPM-8 PORTAL MONITOR

RANGE: Portal Channels (7), 0-1000 CPM full scale.
Threshold Channel (1), 0-2000 CPM full scale.

RESPONSE TIME: 2 to 4 seconds continuously variable.

ALARM SETTING: Minimum 1.5 x background reading.

SENSITIVITY: Less than 0.15 μc (Beta/Gamma) on body surfaces.
Less than 2 μc (Beta) on soles of shoes.

DETECTORS: Portal Frame – 7 T/A No. T-1120 Halogen-quenched tubes.
Threshold – 4 T/A No. T-1100 Halogen-quenched tubes.

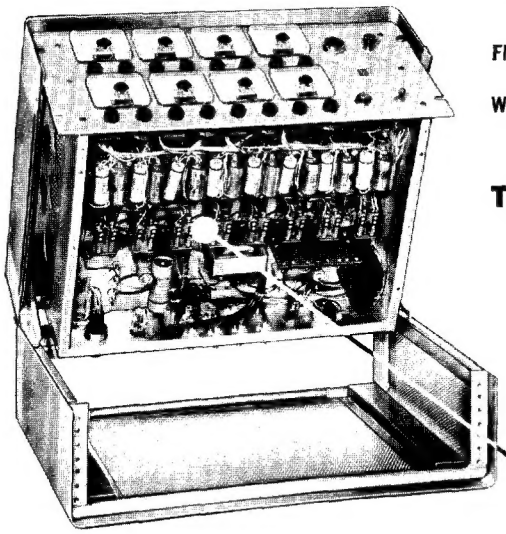
REMOTE ALARM RESET: Back panel mounted jack for remote reset accessory.

POWER SUPPLY REQUIRED: 110 volt 60 cycle 50 watts.

DIMENSIONS: Portal Frame (Outside) – 20″ wide x 15″ deep x 84″ high.
(Inside) – 16″ wide x 15″ deep x 77″ high.
Console Cabinet – 22″ wide x 15″ deep x 11″ high.

FINISH: Portal and Console Cabinet – Hammertone grey.
Console Panel – Flat dark grey.

WEIGHT: Portal, 98 lbs. Console, 54 lbs. Total packed for shipment, 200 lbs.



T/A Easy-to-Service CONSOLE CABINET

Top section raised to service tubes and upper chassis.

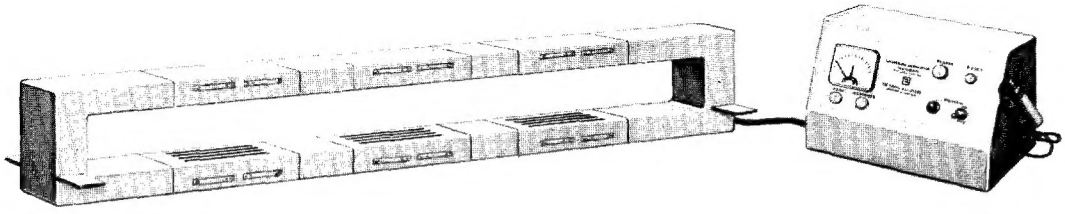
Complete chassis and panel raised to service circuit boards and under-chassis components.

LIM-18 LAUNDRY INSPECTION MONITOR

This is a simplified, low-cost instrument for monitoring clothing and equipment worn in Beta/Gamma contaminated areas. After being washed and prior to re-issue, the material is passed through the monitoring frame where it is scanned by six lead-shielded detectors. Laundered material having residual contamination in excess of permissible preset level will cause an immediate alarm at the Single Channel Radiation Console. A T/A Model P-7 Hand Probe is standard equipment with the Model LIM-18 Monitor for the purpose of localizing detected contamination.

SPECIFICATIONS

RANGE: 0-2000 CPM full scale.
RESPONSE TIME: 2 to 4 seconds.
ALARM SETTING: Minimum 1.5 x background reading.
DETECTORS: 6 T/A No. T-1120 Halogen-quenched tubes in frame.
1 Victoreen 1B85 G/M tube in hand probe.
SENSITIVITY: Less than 0.15 micro-curies (Beta/Gamma).
POWER SUPPLY REQUIRED: 110 volts 60 cycle 35 watts.
DIMENSIONS: Frame approximately 44″ wide x 4″ high inside.
(Can be varied within reasonable limits.)
WEIGHT: Total shipping – 175 lbs.



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INSTRUMENTATION FOR NUCLEAR RESEARCH

CUTIE PIE, MODEL CP-3

PORTABLE ALPHA, BETA, and GAMMA SURVEY METER

- **Built-in alpha and beta absorption filters.**
- **3 ranges: 0-50, 500, or 5000 mr/hr.**
- **Selector switch positions permit testing of all batteries before use.**
- **New battery pack provides over 800 hours of operating life.**
- **Thin end window permits alpha detection.**

APPLICATION: The Model CP-3 Cutie Pie Survey Meter is an improved version of the Model CP-2. This portable instrument measures and distinguishes between alpha, beta, and gamma radiation. Designed for laboratory, reactor, and industrial use, it has found wide acceptance wherever radioisotopes are handled. The Model CP-3 is especially useful in health physics work to monitor such inaccessible spots as corners, behind pipes, beams, etc.

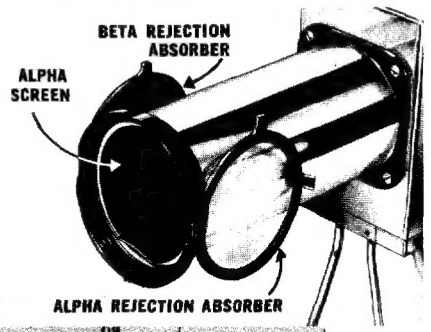
Three full-scale ranges of 50, 500, and 5000 milliroentgens per hour provide excellent coverage of radiation levels encountered in most laboratories. The tolerance rate of 7.5 mr/hr for a 40-hour week is easily read on the 50 mr/hr range. To assure maximum reliability, the range selector switch includes 3 test positions for checking batteries prior to use.

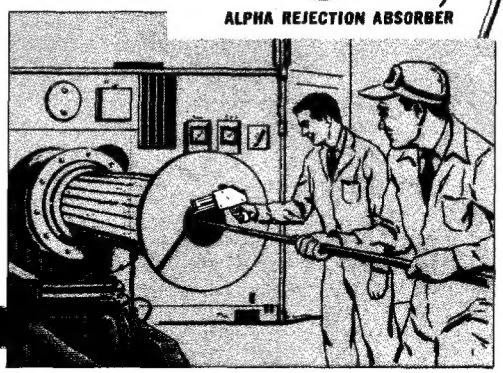
DESCRIPTION: The Model CP-3 Cutie Pie is a gun-type survey meter comprising an ionization chamber, an electrometer circuit, absorption filters for the rejection of alpha or beta particles, an indicating meter, and a battery complement identical to that of the Juno Radiation Survey Meter, Models SRJ-6 or HRJ-6. The undesired radiations are easily rejected by swinging the proper absorber into place in the absorber bracket mounted on the front of the ionization chamber.

The Model CP-3 has a bright, chrome-plated all-aluminum ionization chamber and case. The end of the chamber is closed with a rubber hydrochloride alpha screen .0003" thick (0.45 mg/cm^2), which is frame-mounted and held in place by clips, thus permitting its easy replacement. The case is chrome-plated aluminum for easy cleaning and decontamination. All edges are rounded. Rubber gaskets provide protection against high humidity conditions.

The T/A Model CP-3 incorporates circuit improvements and battery pack which extends the battery life to more than 800 operating hours and permits the testing of all batteries prior to use. This is done by turning the selector switch to each of the 3 battery test positions. Batteries of proper voltage produce a reading in the green sector on the meter. A set position permits the meter to be adjusted to read zero even in a radiation field. The remaining 3 switch positions permit the selection of radiation measuring ranges.

Model CP-3 is shown with both absorption filters locked at side of the chamber.





Cutie Pie is shown testing radioactivity of vacuum melted steel.

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PECIFICATIONS

RADIATION RANGES: 50, 500, and 5000 mr/hr full scale.

CALIBRATION: Factory calibrated, using gamma standard calibrated by the National Bureau of Standards. Calibration accuracy ±10%. Internal individual calibration controls for each range, screwdriver adjusted from outside of case. Access is permitted by means of snap plugs.

CIRCUIT: Reliable single tube electrometer circuit. Ranges of sensitivity are obtained by switching input grid resistors. This is accomplished by a special Teflon insulated switch. All high resistance points in the circuit are insulated with Teflon or Kel-F to insure minimum leakage. Ranges and corresponding input resistance are:

50 mr/hr	1.4×10^{11} ohms
500 mr/hr	1.4×10^{10} ohms
5000 mr/hr	1.4×10^{9} ohms

The circuit contains five individual potentiometers for purposes of zeroing and calibration.

METER: High quality 3½" meter, scale length 2.36", with 50 scale divisions. Appropriately calibrated to read in milliroentgens per hour for gamma radiation. Mounted in position to permit excellent visibility.

CONTROLS: Single control switches meter to zero position, battery test points, and 3 operating ranges. Meter Zero Control is located directly below the meter and zeros the meter by adjusting the filament voltage. Coarse Meter Zero Control and Calibration Control are screwdriver adjustments located beneath snap plugs on sides of instrument case and are provided for use only after battery voltages have dropped considerably.

TIME CONSTANTS: Range 50 mr/hr 6 seconds
Range 500 mr/hr less than 1 second
Range 5000 mr/hr less than 1 second

ZERO DRIFT: Negligible after 15 minutes warm-up period.

BATTERY LIFE: Over 800 operating hours.

IONIZATION CHAMBER:
Aluminum Cylinder: 2⅞" inside diameter, 6⅜" long.
Volume: Approximately 36 cubic inches.
Window opening: 2¾" in diameter.
Alpha Screen: Easily removable, ring-mounted rubber hydrochloride .0003" thick (0.45 mg/cm²).
Alpha Rejection Absorber: Hinge held, ring-mounted cellulose acetate 0.01" thick.
Beta Rejection Absorber: Hinge held, aluminum disc 0.102" thick.

CASE: Formed and welded sheet aluminum with chrome finish and large, clearly engraved markings.

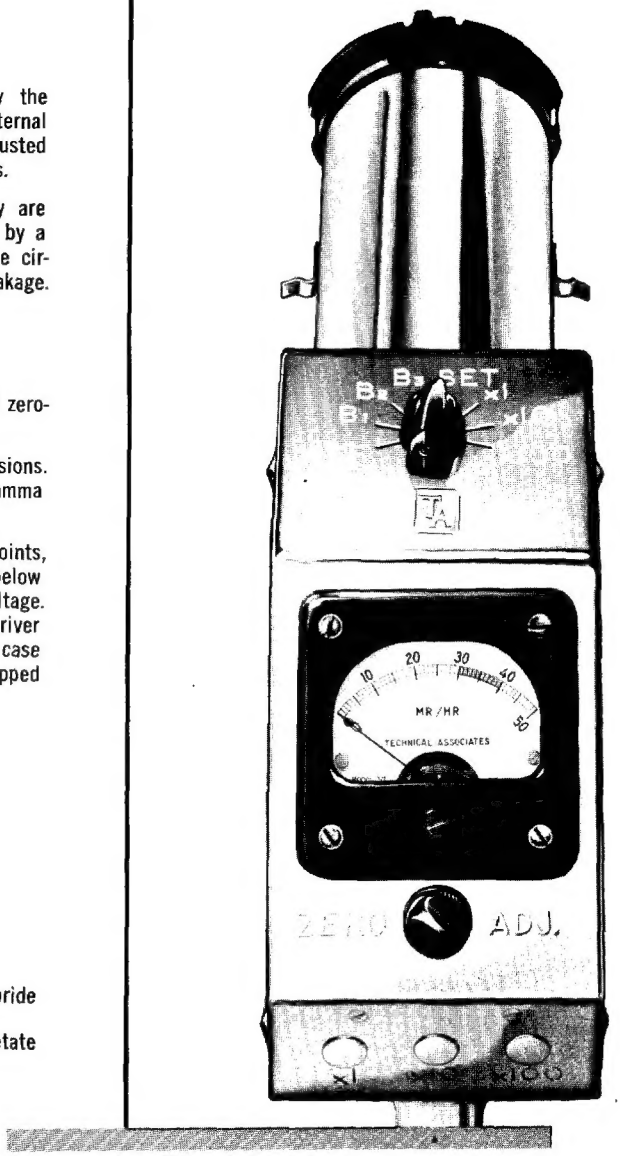
HANDLE: Cast aluminum, free from porosity and highly polished. Hollow construction to reduce weight.

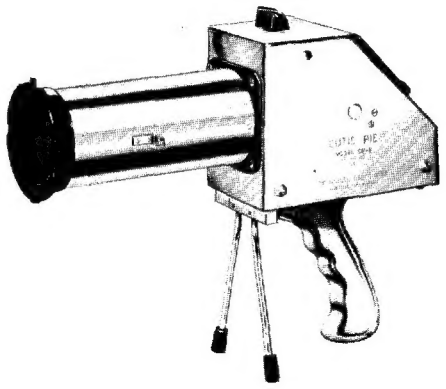
BATTERY COMPLEMENT:
4 Eveready No. 412 22½ Volt "B" Batteries
2 Eveready No. E12 1.35 Volt "A" Batteries
2 Mallory No. TR-115 6.5 Volt "B" Batteries

VACUUM TUBE: Raytheon Type 5886.

WEIGHT: 4 lbs. 12 oz. net. Shipping Weight: 8 lbs.

A special Model CP-3A is available at slightly higher cost, for applications where higher sensitivity is required. This instrument is equipped with ranges of 0-25, 0-250, 0-2500 mr/hr.





MODEL CP-3 CUTIE PIE,
with front tripod feet in position for bench or table use.

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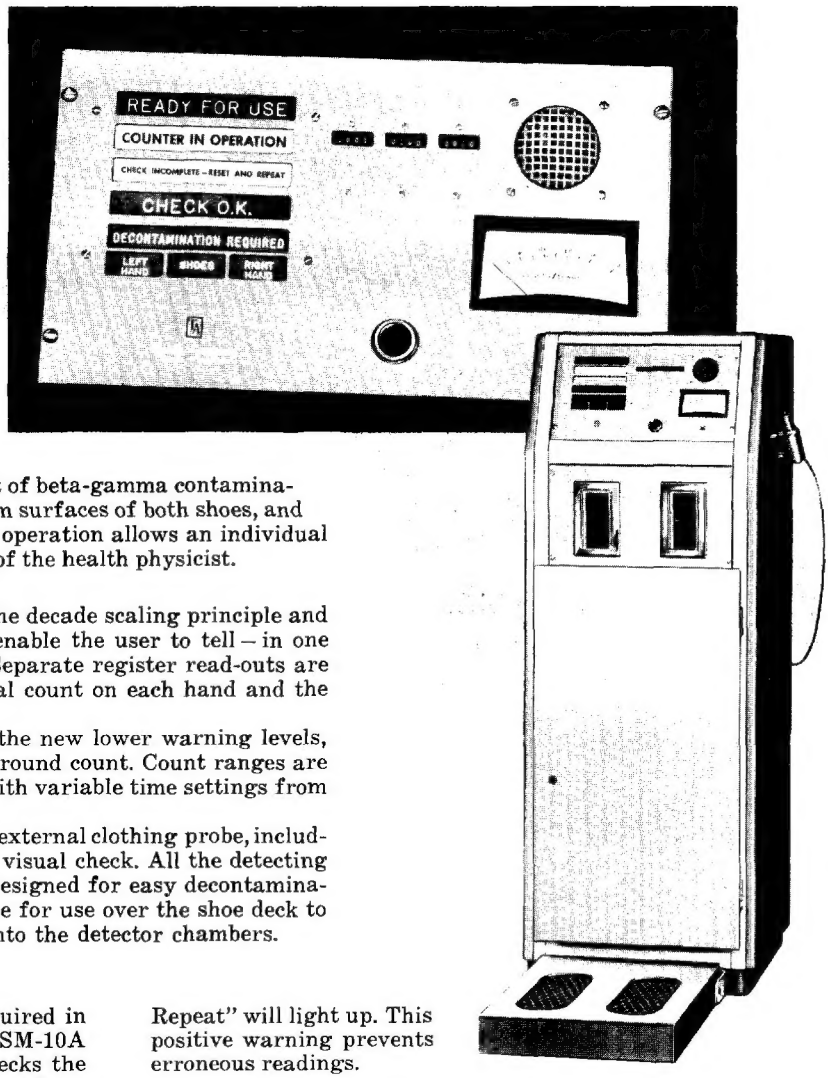
INSTRUMENTATION FOR NUCLEAR RESEARCH

Beta-Gamma HAND and SHOE MONITOR

Model HSM-10A

- **Completely automatic monitoring.**
- **Error-proof, illuminated read-out panel.**
- **Alarm settings as low as background.**
- **Positive warning of incomplete check.**
- **External clothing probe with separate circuitry, meter, and speaker.**

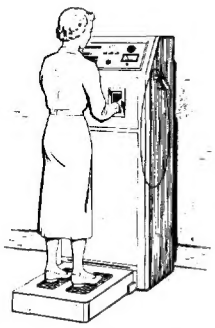


APPLICATION. The Model HSM-10A Hand and Shoe Monitor is a health physics instrument designed to provide completely automatic detection and measurement of beta-gamma contamination on the palm and back of each hand, the bottom surfaces of both shoes, and also the hair and clothing. Its simple, fool-proof operation allows an individual to perform this check without direct supervision of the health physicist.

DESCRIPTION. The Model HSM-10A employs the decade scaling principle and features illuminated multi-colored panels that enable the user to tell – in one look – whether he is contaminated, and where. Separate register read-outs are provided on the monitor panel, showing the total count on each hand and the combined count for both shoes.

An outstanding feature of the instrument is the new lower warning levels, which permit alarm settings as low as the background count. Count ranges are adjustable from 10 to 190, in increments of 10, with variable time settings from 1 to 120 seconds.

A separate rate meter circuit is utilized for the external clothing probe, including a speaker for audible check and a meter for visual check. All the detecting elements and sections exposed to radiation are designed for easy decontamination. A roll of kraft paper is mounted in the base for use over the shoe deck to prevent contaminated material from dropping into the detector chambers.



OPERATION. No skill is required in the operation of the Model HSM-10A Monitor. The user simply checks the illuminated multi-colored panels on the front of the instrument.

When the monitor is turned on, the blue "Ready for Use" panel will be illuminated. The user merely steps on the shoe deck and inserts hands into the two waist-high probe openings. The counting process is started and continued by pressure of the fingertips at the rear of the probe openings, and by the weight of the person on the shoe deck. As soon as the counting starts, the "Ready for Use" panel darkens, and the yellow "Counter in Operation" panel lights up.

NOTE: If at any time during the counting cycle, the user removes either hand from the hand probe or steps off the shoe deck, the cycle will automatically stop and the orange panel reading "Check Incomplete – Reset and Repeat" will light up. This positive warning prevents erroneous readings.

As soon as the preset time has elapsed, the "Counter in Operation" panel darkens and either the green "Check O.K." panel or the bold red "Decontamination Required" panel lights up, depending upon whether the radioactivity present is above or below the alarm setting. If decontamination is required, bold red panels marked "Left Hand," "Right Hand," or "Shoes" will light up, indicating the location of contamination. The degree of contamination is indicated by the registers on the monitor panel.

The clothing probe, mounted on the right side of the instrument, is used to detect contamination on the hair and clothing. The output of the clothing probe is read visually on the count rate meter and aurally by the speaker, both of which are mounted on the monitor panel.

After the check is completed, the user pushes the large red "Reset" button on the front panel, and the instrument is ready for the next user.

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4-DIGIT SODECO REGISTERS

MULTI-COLORED ILLUMINATED PANELS

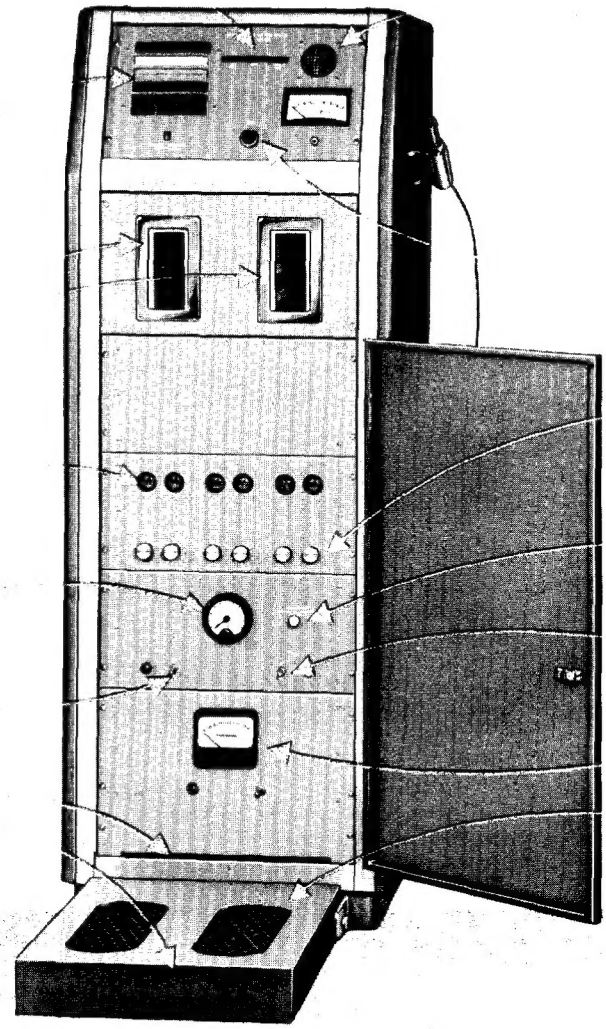
HAND PROBES

GLOW DECADE TUBES FOR SCALING CHANNELS

INTERVAL TIMER

POWER ON/OFF

SLOTS FOR DISPOSABLE PROTECTIVE PAPER



CLOTHING PROBE SPEAKER

CLOTHING PROBE AND HOLDER

AUTOMATIC RESET PUSH-BUTTON

SWITCHES TO VARY THE SCALING FACTORS

SWITCH FOR BACKGROUND TEST AND 60-CYCLE TESTING

TIMER ON/OFF

HIGH VOLTAGE METER

SHOE DECK

Alarm Settings: Preset Count Ranges: 10 to 190 counts, in increments of 10. Preset Time Periods: Variable from 1 to 120 seconds.

Sensitivity: Less than 0.15 μc of 0.2 MEV or higher energy.

Detectors: Hand Probes: 4 T/A Type T-1100 halogen quenched Geiger tubes in each hand probe.

Shoe Deck: 2 T/A Type T-1100 halogen quenched Geiger tubes in each shoe probe.

Clothing Probe: 1 T/A Type T-1110 halogen quenched Geiger tube.

Shielding: Hand and shoe detectors are shielded with ½" of lead.

Register Range: 0 to 9999, four digits on each of three Sodeco Registers.

Speaker for Clothing Probe: 2½" adjustable volume.

Meter for Clothing Probe: 5" Assembly Products meter, registering to 10,000 cpm.

Power Requirements: 105 to 125 volts, 60 cycle A.C., 300 watts.

Dimensions: Cabinet: 67¾" high x 27½" wide x 24" deep. Shoe Deck: 23" long x 18" wide x 4¼" high.

Finish: Grey baked enamel.

Shipping Weight: 650 lbs.

The complete unit is housed in a sturdy metal cabinet with grey baked enamel finish. Locked doors cover all controls, protecting the instrument from misadjustment by unauthorized personnel.

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TA

THE NU-TEC POCKET MONITOR MODEL RM-100

A Transistorized Pocket Type Radiation Detector

NUCOR'S new, inexpensive, wide range fully transistorized pocket monitor is a Geiger-Mueller tube type radiation detector of the most modern design.

Packaged in a lightweight non-breakable plastic case, it is the ideal instrument for carrying in a pocket or belt holder for health physics purposes.

SPECIFICATIONS

RANGES: Four scales:
0-10 mr/hr; 0-100 mr/hr;
0-1000 mr/hr; 0-100 r/hr.

ENERGY DEPENDENCE:
±15% for gamma or X-ray energies between 80KEV and 1.2 MEV.

SATURATION CHARACTERISTIC:
Will not jam or saturate in any field.

OPERATION CHECK:
All electronic circuits can be checked by a test position on the function selector switch. Complete radiological operation can be checked with a small radioactive source, such as a luminous watch dial.

READOUT: 1-1/2" meter provides immediate and visual readout. Phone jack provided for earphone.

CASE: Hi-impac plastic. Waterproof and shock resistant.

SIZE: 2 - 5/8" x 4-1/2" x 1-3/8" deep.

WEIGHT: 10 ounces

POWER SUPPLY: One 4 volt battery provides more than 40 hours of continued operation.

MANUAL: Complete operating and instruction manual provided.

ACCESSORY KIT: Earphone and Radioactive Test Source Included.

PRICE COMPLETE: $52.95 Includes Accessory Kit

RM-100/62

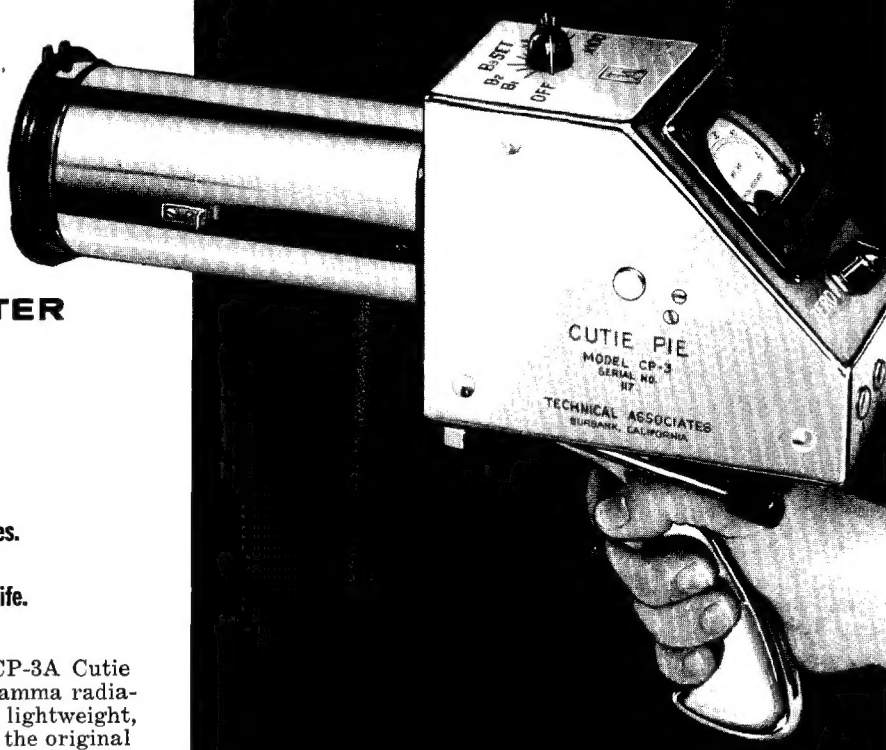
NUCLEAR CORPORATION OF AMERICA
Instrument and Control Division
DENVILLE, NEW JERSEY

INSTRUMENTATION FOR NUCLEAR RESEARCH

CUTIE PIE

MODELS CP-3 and CP-3A

PORTABLE ALPHA, BETA, and GAMMA SURVEY METER



- **3 linear ranges to 5000 mr/hr.**
  CP-3: 0 to 50, 500, or 5000 mr/hr.
  CP-3A: 0 to 25, 250, or 2500 mr/hr.
- **Thin window permits alpha detection.**
- **Built-in alpha and beta absorbers.**
- **Selector switch positions permit checking all batteries.**
- **Zero adjustment in radiation field.**
- **New battery pack provides over 800-hour operating life.**

APPLICATION The T/A Models CP-3 and CP-3A Cutie Pie Survey Meters measure alpha, beta, and gamma radiation with excellent energy independence. These lightweight, portable instruments are improved versions of the original Cutie Pie design, which was developed under the Manhattan Project. They have found wide acceptance by health physicists for surveys at reactor sites and research and industrial laboratories, and are extensively used for determining shielding effectiveness, checking source shipping containers, monitoring areas, as well as for decontaminating and clean-up purposes. They are especially useful for monitoring such inaccessible spots as corners, behind pipes, beams, etc.

DESCRIPTION. The Models CP-3 and CP-3A comprise an ionization chamber, an electrometer circuit, alpha and beta absorbers, battery pack, and an indicating meter. Both units are battery operated and self-contained.

The ionization chamber is made of aluminum and coated internally with aquadag. The end of the chamber is closed with a rubber hydrochloride alpha window (0.45 mg/cm^2), which is frame-mounted and held in place with clips, thus permitting easy replacement. Alpha and beta absorbers are mounted with hinges on the front of the chamber. Undesired radiations are easily rejected by swinging the proper absorber into place.

Each instrument has three linear ranges: the CP-3 provides 0 to 50, 500, or 5000 mr/hr; the CP-3A provides 0 to 25, 250, 2500 mr/hr. These ranges provide excellent coverage of radiation levels normally encountered. To assure maximum reliability, the range selector switch includes three test positions for checking batteries prior to use. Batteries of proper voltage produce a reading in the green sector on the meter. A "Set" position permits the meter to be adjusted to read zero even in radiation fields. The remaining three switch positions permit the selection of ranges.

The instrument case is made of chrome-plated aluminum, with engraved lettering for easy decontamination. Rubber gaskets are used for protection against high humidity. The case contains the range selector switch, the zeroing control, and a large-face meter calibrated to read milliroentgens per hour, with 50 scale divisions. The meter is mounted in position for excellent visibility. A reliable high impedance electrometer circuit with an improved 800-hour battery complement assures long uninterrupted service. Both Models CP-3 and CP-3A provide front tripod feet for bench or table use.

Cutie Pie is shown testing radioactivity at reactor site.

TA

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Printed in U

pecifications
of MODELS CP-3 and CP-3A

RADIATION RANGES: CP-3: 50, 500, and 5000 mr/hr full scale. CP-3A: 25, 250, and 2500 mr/hr full scale.

CALIBRATION: Factory calibrated, using gamma standard calibrated by Nat'l Bureau of Standards. Calibration accuracy ±10%. Individual calibration control for each range.

CIRCUIT: Reliable single tube electrometer circuit. All high resistance points are insulated with Teflon or Kel-F to insure minimum leakage.

METER: High quality 3½" meter, with 50 scale divisions. Appropriately calibrated to read in milliroentgens per hour for gamma radiation.

CONTROLS: Single control switches meter to battery test points, zero position, and 3 operating ranges. Meter Zero Control is located directly below the meter.

ZERO DRIFT: Negligible after 15 minute warm-up.

TIME CONSTANTS:

CP-3: Range 50 mr/hr, 6 seconds • Range 500 mr/hr, less than 1 second • Range 5000 mr/hr, less than 1 second.

CP-3A: Range 25 mr/hr, 12 seconds • Range 250 mr/hr, 2 seconds • Range 2500 mr/hr, 1 second.

IONIZATION CHAMBER:

Aluminum Cylinder: 2⅞" inside diameter, 6⅜" long.
Volume: Approximately 36 cubic inches.
Window Opening: 2¾" diameter.
Alpha Window: Removable, ring-mounted rubber hydrochloride (0.45 mg/cm²).
Alpha Absorber: Hinge-held, ring-mounted cellulose acetate (36 mg/cm²).
Beta Absorber: Hinge-held, aluminum disc (720 mg/cm²).

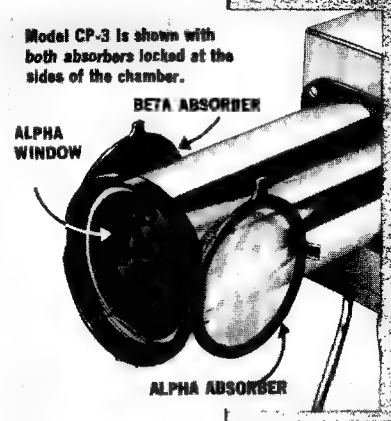
CASE: Chrome-plated aluminum, with clearly engraved markings.

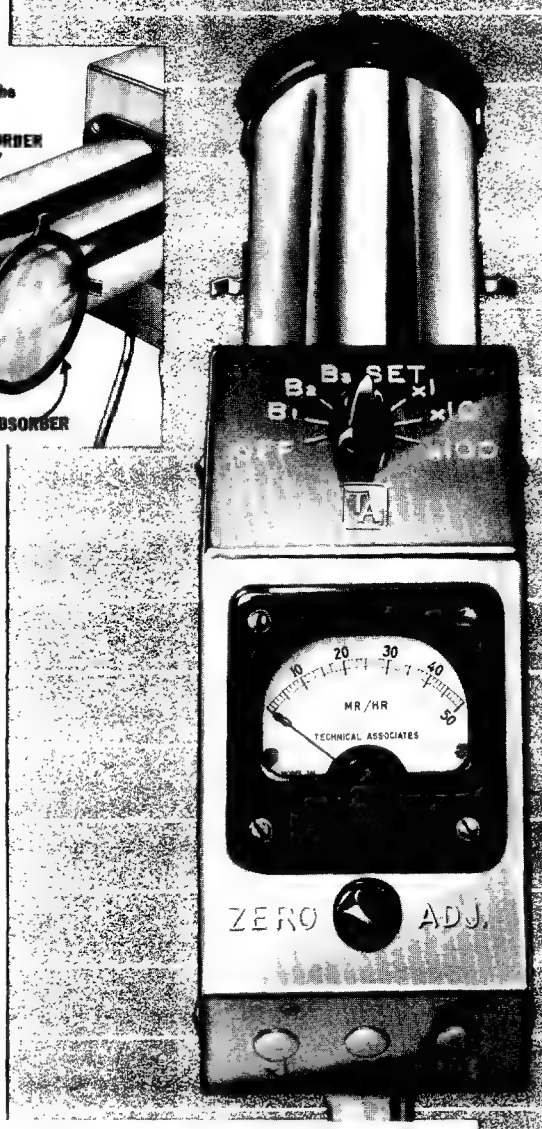
BATTERY LIFE: Over 800 operating hours.

BATTERY COMPLEMENT:

4 Eveready No. 412 22½ Volt "B" Batteries
2 Eveready No. E12 1.35 Volt "A" Batteries
2 Mallory No. TR-115 6.5 Volt "B" Batteries
(Battery complement is identical to the Model 7 Juno and CP-4.)

WEIGHT: 4 lbs. 12 oz. net. Shipping Weight: 8 lbs.

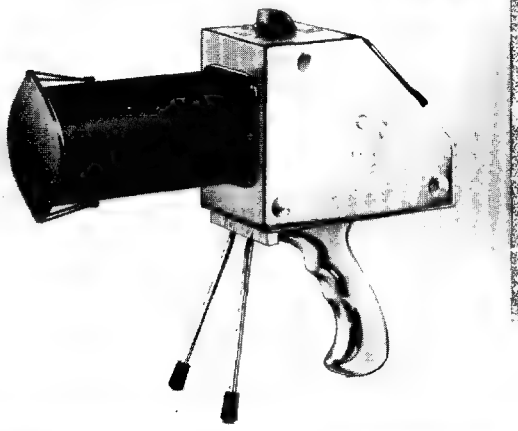




CUTIE PIE, MODELS CP-4 and CP-4A
PORTABLE BETA and GAMMA SURVEY METER

For those customers who prefer a Cutie Pie with a chamber made of bakelite, instead of aluminum, and who require measurements of beta and gamma only, T/A offers Models CP-4 and CP-4A. These instruments utilize the same electrometer circuitry and include the outstanding features and specifications of Models CP-3 and CP-3A. The Model CP-4 has the same ranges as the Model CP-3 (0 to 50, 500, or 5000 mr/hr); while the Model CP-4A has the same ranges as the Model CP-3A (0 to 25, 250, or 2500 mr/hr).

The bakelite chamber of the Models CP-4 and CP-4A has a beta end-window (6 mg/cm²), permitting detection of low energy beta particles. They have a bakelite beta absorber (432 mg/cm²), in the form of a cap, which is easily placed in position over the end, thus permitting measurement of gamma only.



MODEL CP-4 CUTIE PIE
with front tripod feet in position for bench or table use.

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Manual of Operation and Service Instructions

NUCLEAR INSTRUMENT & CHEMICAL CORPORATION

INSTRUCTION BOOK

MODEL 2610A

#1747

SECTION I

GENERAL DESCRIPTION

PURPOSE

Model 2610A count-rate meter is a lightweight battery operated instrument designed for general survey work and for the location of small amounts of beta and gamma radiation in rooms, laboratories, on desks, laboratory coats, and similar areas. It has also been found useful for X-ray monitoring and geological surveying for radioactive ore.

GENERAL SPECIFICATIONS

1. The instrument consists of a single unit containing all circuit components, electron tubes, batteries, and a count-rate meter.

2. The detector is a thin-wall Geiger counter mounted in a metal probe at the end of a three foot cable. The probe has a rotary shield which, when covering the sensitive area of the counter, effectively cuts out beta radiation. The instrument then reads only the gamma ray component of the incident radiation, excluding all but the highest energy beta rays commonly encountered.

3. Three full scale ranges of 20, 2, and 0.2 milliroentgens per hour (mr/hr) have been provided to permit quick and convenient measurements of radiation dosage rates.

4. Each instrument is calibrated at the factory with a known ionization intensity produced by gamma rays from radium in equilibrium with its short-lived decay products.

5. When it is inconvenient to read the meter, the earphones may be plugged into the jack on the instrument. One "click" is produced in the phones for each ionizing event occuring in the counter.

MECHANICAL SPECIFICATIONS

1. The count-rate meter is housed in an aluminum case with a smooth enamel finish to make surface decontamination easy.

2. The instrument is ruggedly constructed for long operating life with both case and probe sealed against moisture.

3. The probe is conveniently mounted in the handle of the unit and is easily removed.

4. The range switch is located below the handle and can be controlled with a fingertip while the probe is carried in the other hand.

5. The plug-in Geiger tube (model D50) has a three pin "pee wee" base, requires no soldering, and the probe is quickly disassembled by a simple twist when necessary.

6. Cabinet dimensions: 10" x 4-3/4" x 5-3/4" deep.

7. Weight: 9-1/2 pounds.

ELECTRICAL SPECIFICATIONS

All the batteries necessary for proper operation of the instrument are shipped with the equipment. They consist of:

1. Three 300 volt battery packs which are used for GM tube potential. The life of these batteries is equal to shelf life.

2. One 67.5 volt battery which is used for B-plus potential.

3. One 1.5 volt battery which is used for filament potential.

The life of the 67.5 volt and 1.5 volt batteries is adequate to maintain sensitivities within 10% when operated continuously for 100 hours. When operated four hours a day, the life of these batteries is over 250 hours.

SECTION II

OPERATION

FACTORY CALIBRATION

The instrument has been calibrated using gamma rays from a radium source with the rotary shield on the metal probe closed. Therefore, the shield should be closed when reading gamma radiation in order to preserve the calibration. With the shield closed, no beta rays will be able to penetrate into the chamber and affect the reading. Gamma rays can thus be monitored in the presence of a beta background. When it is desired to admit beta rays into the chamber, the shield should be set in the open position.

The calibration of the instrument may be checked by use of the radium calibration source supplied with the unit.

RADIUM CALIBRATION SOURCE

The radium calibration source provides a convenient means of checking the calibration of the instrument. It is contained in a small plastic cylinder mounted at the rear of the instrument case.

To use the calibrating source, open the probe shield and hold a flat side of the source against the unshielded section of the probe. Move the source until the maximum reading of the meter is observed. The numerals stamped on that side of the source next to the Geiger counter represent the reading in mr/hr. which should be indicated on the meter. If the error is greater than 5% of full scale, readjust the instrument by means of the CALIBRATE control located at the top of the instrument.

The background reading of the meter will be increased if the calibrating source is mounted in its holder while the instrument is in use. If the source is not moved some distance from the instrument, this increase in meter reading should be taken into account.

TAKING A COUNT

When taking a count the Geiger counter may be used in its attached position if desired, or removed for probing in confined spaces or small areas.

The range switch has four positions: OFF and three full scale sensitivity selections of 20, 2, and 0.2 milliroentgens per hour. The maximum total dose to which any part of the body of a person shall be exposed continuously or intermittently in a given time is now 300 milliroentgens per week. On the basis of 48 hours per week of uniform exposure, the permissible dosage rate is 6.25 mr per hour. This dosage rate is indicated on the 20 mr/hr. scale.

The range switch should be turned first to the least sensitive scale (20 mr/hr) to prevent harming the meter if a strong radiation field is present. No warm-up period is necessary. The count-rate meter is ready to operate almost instantly. If no reading appears on the 20 mr/hr scale, the switch should be turned to the next more sensitive scale, etc. With the radium calibrating source removed from the vicinity of the instrument, cosmic ray background will indicate about 1/10 of full scale on the 0.2 mr/hr. range.

SECTION III

CIRCUIT THEORY

GEIGER TUBE

The Geiger tube used with the instrument detects beta and gamma radiation from a radioactive source. The three 300 volt batteries in series produce a 900 volt electric field between the anode and cathode of the Geiger tube. Entering beta or gamma rays

collide with the atoms of gas in the tube, causing ionization of the gas and resulting in a current flow between the electrodes. The random height, random width voltage pulses produced by this minute current flow are then fed to a two tube self-relaxing trigger circuit. Refer to the schematic diagram at the rear of this manual.

TRIGGER CIRCUIT

The output of the GM tube is differentiated (sharpened) by C1 and R3 and fed to a one-shot multivibrator, or trigger circuit. The first tube of the trigger circuit (VT-1) is normally conducting, developing a DC voltage with respect to ground on the filaments of both tubes and biasing the second tube of the trigger circuit to cut-off.

When a negative pulse from the Geiger tube is impressed on the grid of VT-1, the conduction of the tube decreases and its plate goes in a positive direction. This positive surge in plate voltage is transmitted to VT-2 through C4, C5, or C6 and VT-2 then leaves cut-off. The plate current through VT-2 will further bias the first tube. This process will be self-maintaining and will terminate when the first tube is fully cut-off and the second tube is conducting heavily.

As C4, C5, or C6 becomes charged, the grid of VT-2 approaches the cathode potential. At this point, grid-cathode conduction ceases and the charging proceeds at a slower rate through R9, R10, and R5. The grid of VT-2 gradually goes negative decreasing the current flow through the tube and decreasing the bias on VT-1. When this bias decreases to the point where plate current will once again flow in the first tube, the circuit will rapidly trigger back to the initial condition with VT-1 conducting heavily and VT-2 cut-off. The time during which the second tube is conducting is varied by the range selector switch which changes the time constant of the coupling circuit. Since the range selector switch varies the "on" time of the second tube, it changes the number of input pulses necessary to give the same average current flow through VT-2.

METER-INTEGRATING CIRCUIT

Each time VT-2 conducts, a pulse of current is put into the meter integrating circuit made up of R8, C7, and the meter in the plate circuit of VT-2. These pulses of current are averaged by the charging and gradual discharging of the condenser through the resistor and meter. The time constant of the meter-integrating circuit, i.e., the time it takes the meter to reach 63% of its final reading is about 5 seconds. It will be noted that for any given amount of radiation, the meter needle fluctuates around an average reading; the largest fluctuations being on the most sensitive scale (0.2 mr/hr). This is due to the randomness of the radiation flux. The observer's final reading should be the average position, as seen by the eye, of the fluctuating needle.

LINEARITY

The linearity of the electronic count rate circuit corresponds very favorably (about 2%) with the linearity of the 0-20 micro-amp meter. However, the resolution time of the Geiger counter causes coincidence losses at the higher counting rates. The counter is insensitive for a time equal to:

$$N \frac{T}{60} \text{ Minutes during each minute.}$$

Where N = observed count rate in counts per minute
T = resolution time in seconds

Two particles or quanta entering the counter within this time interval produce only one pulse since the second particle enters the counter before most of the positive ions from the previous discharge are collected. Because of the random nature of emissions from a radioactive source, there is as much chance for pulses to occur during this time as during any other of equal duration.

Thus, the higher the counting rate, the higher is the number of counts "lost". Coincidence loss has been minimized on the 2 and 20 mr/hr. ranges by the introduction of slightly larger capacitors (C4 and C5) in the coupling circuit. Figure 1 shows the deviation of an average instrument from true linear calibration.

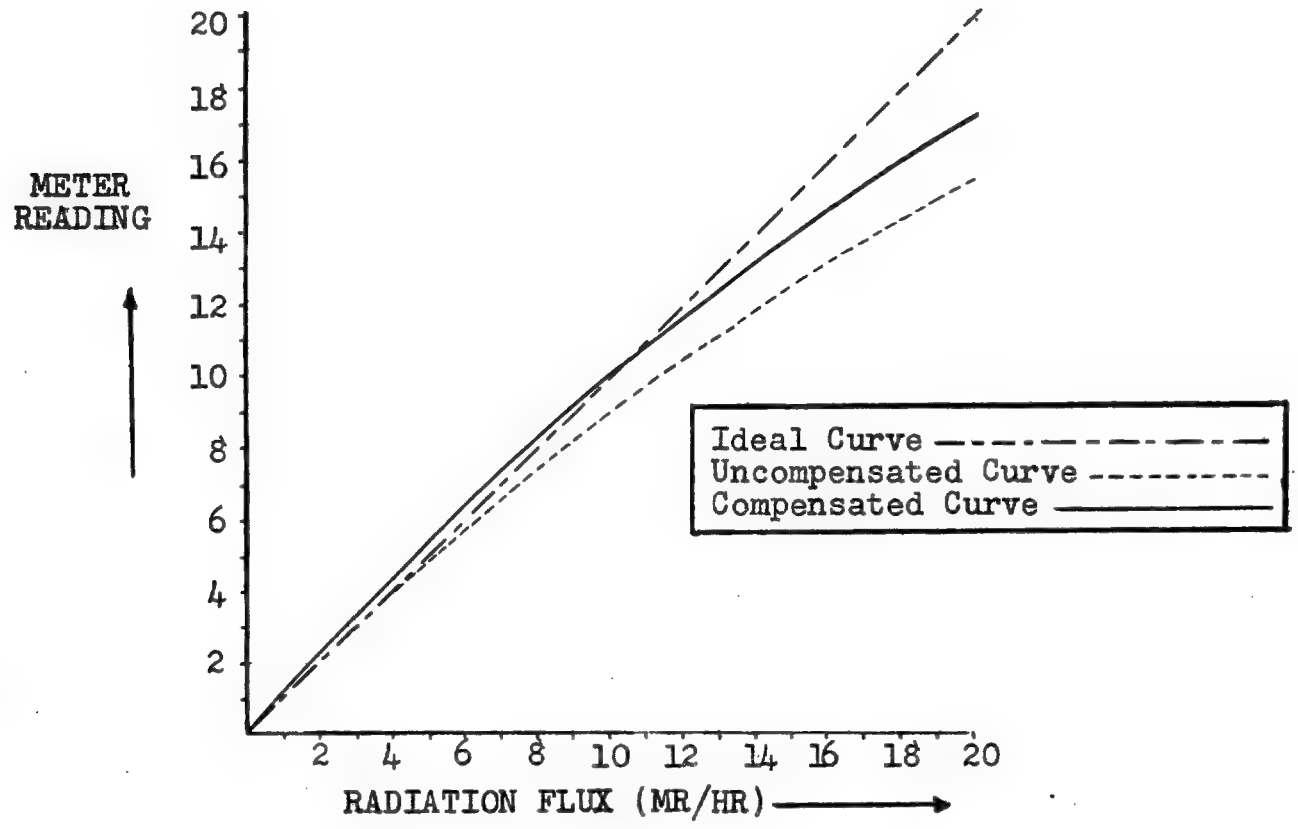


Figure 1

CALIBRATION CORRECTIONS *

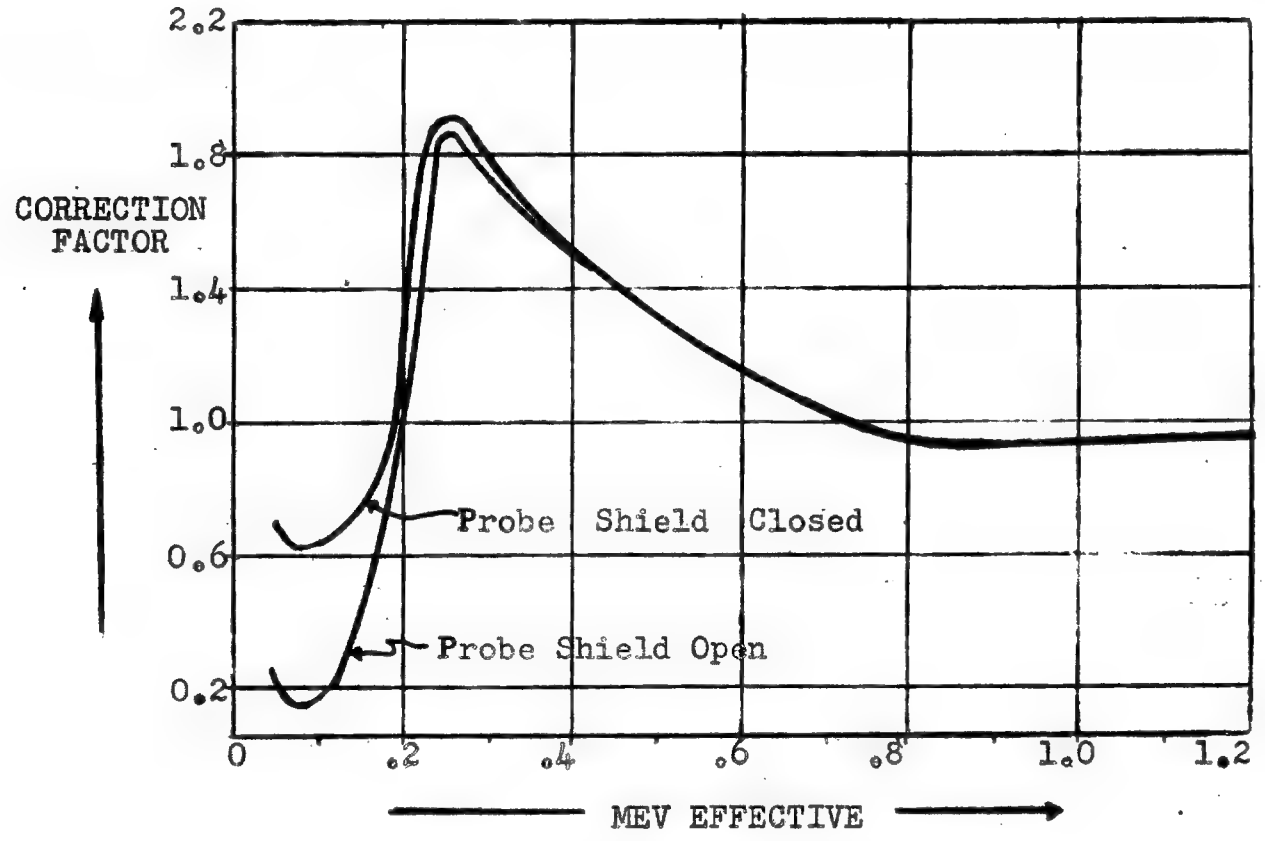
A plot of correction factor versus photon energy for a Geiger-Müller counter is shown below. For energies above 750 kv (.75 mev), the correction factor is equal to or near 1.0. For less energetic radiations the plot exhibits maximum and minimum values of correction factors caused by a change in efficiency of the Compton and photoelectric processes.

NOTE

This graph represents average readings taken on a number of 2610A count-rate meters. The graph serves merely to indicate the approximate error which may be expected from low energy radiation and is not to be taken as an absolute guide for each instrument.

This instrument was carefully calibrated at the factory using gamma rays from a radium source in equilibrium with its short-lived decay products. The calibration of the instrument will be correct for radium radiation since the gamma energies of RaC (which is the principle source of gammas in radium decay) fall for the most part on the flat portion of the curve below.

The relative energy and intensity of RaC gammas is given in the



* Excerpt from: National Bureau of Standards Circular No. 507 (7/25/51)

following chart:

ENERGY	RELATIVE INTENSITY
.6 mev	8.9
1.12 mev	2.9
1.76 mev	2.8
2.19 mev	1

From the graph on the opposite page it may be seen that as the energy of radiation is reduced the correction factor rises and reaches a maximum value in the region of .25 to .3 mev. Upon further decreases in energy the correction factor drops rapidly and passes through a minimum around 0.1 mev, after which it again rises sharply.

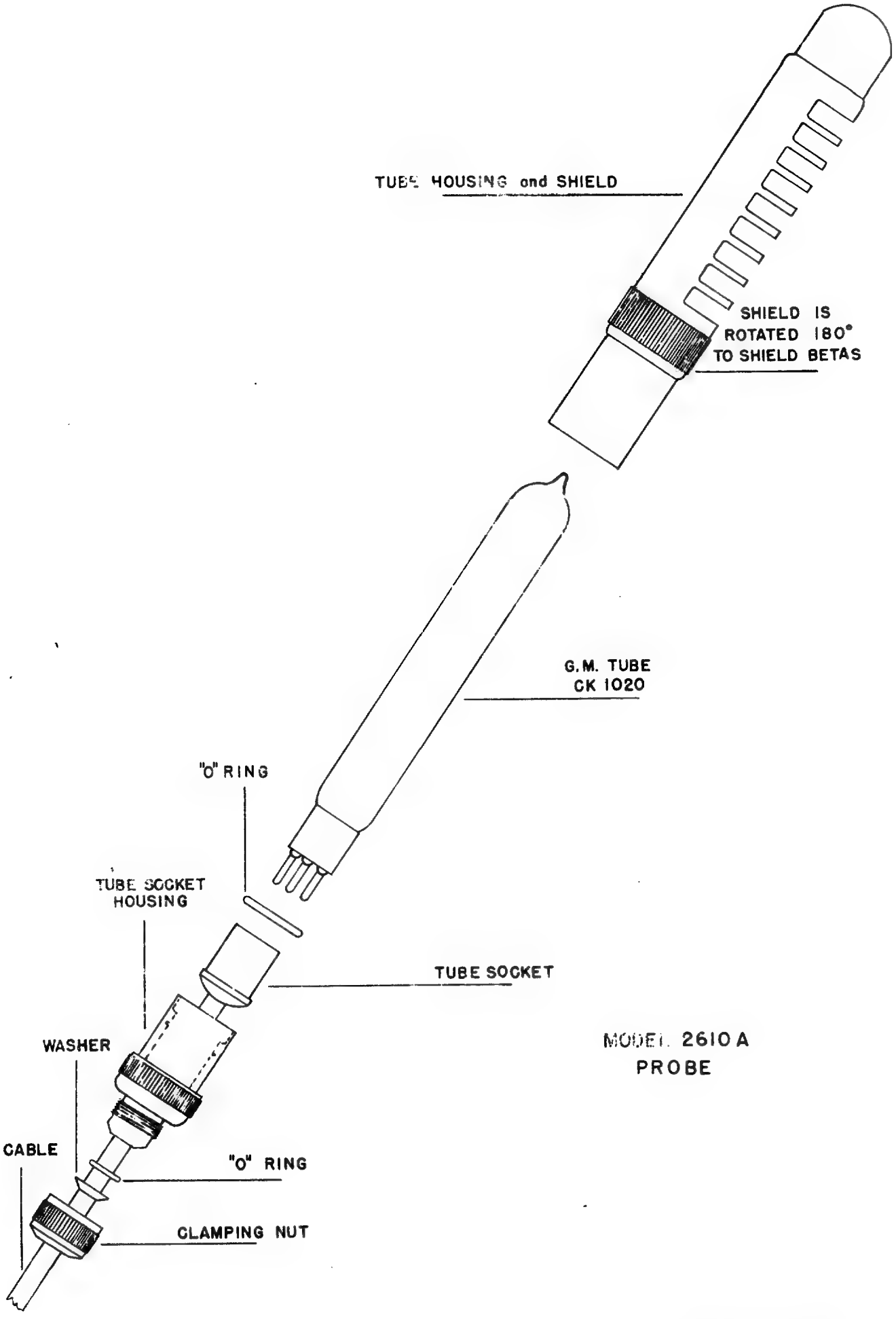
The response of a Geiger-Müller counter depends primarily upon the number of electrons that traverse the sensitive volume of the counter. This number is proportional to the number of electrons released in the vicinity of the sensitive volume and to the range of these electrons. The correction factor of a GM counter varies primarily in proportion to the ratio

$$\frac{\text{Energy of electrons generated in the counter vicinity}}{\text{Range of electrons generated in the counter vicinity}}$$

The range of an electron increases faster than its energy increases at moderately high energies and in direct proportion to its energy in the multimillion-volt region. Therefore, for energies within the plot, the energy-to-range ratio (the correction factor) must increase as the energy decreases. This assumption is approximately valid in the high energy region where most of the electrons arise from the Compton effect, because this effect is almost independent of the mode of binding of the electrons within matter.

At lower energies, electrons are released primarily because of the photoelectric effect. This effect is the more intense the more tightly bound are the electrons within matter, that is, the higher is the atomic number of the material. Therefore, the presence of high-atomic number materials in the proximity of the sensitive volume of a GM counter increases the response to low energy particles sharply. Accordingly, the correction factor must be expected to drop as one proceeds from high to low energies, as soon as the photoelectric effect becomes important. This drop may be seen in the plot and represents increased sensitivity of the GM counter to radiation energies in the 100 kv region.

From the chart it can be seen that the meter reading for low energy gamma emitters is essentially erroneous. To obtain the correct gamma dose rate, it is necessary to multiply the meter reading by the correction factor.



MODEL 2610 A
PROBE

SECTION IV

MAINTENANCE

CALIBRATION WITHOUT A STANDARD SOURCE

If a standard source is not available, an approximate calibration may be obtained by the use of an electronic pulse generator. The pulses should be negative, no more than 75 microseconds wide (preferably much narrower) with a fast rising time.

Feed the pulses into the input grid circuit. The screwdriver adjustment should be made so that full scale on the second range (2 mr/hr.) is indicated when 110 pulses per second are fed into the input. Full scale on the 0.2 mr/hr. range should then be 11.0 pulses per second.

This method of calibration was determined experimentally by averaging the pulses per minute at 1 mr/hr. for a large number of Geiger counters. Individual counters may differ by as much as a factor of two, so this method of calibration should only be used if a radium standard is not available.

GEIGER TUBE REPLACEMENT

1. With the tube socket housing held firmly in one hand and pointed to the operator, grasp the tube housing in the other hand and turn clockwise.

2. Slide the probe tube housing off the Geiger counter, being careful not to break the counter tube..

3. Grasp the Geiger counter by the base and remove it from the socket. CAUTION - The Geiger tube is very fragile and should be handled carefully.

4. See that the "O" ring is in the tube socket housing.

5. Insert a new Geiger counter in the tube socket. "O" ring now forms a seal between the housing and the base of the counter.

6. Carefully slide the probe tube housing over the Geiger counter and turn counter-clockwise on the tube socket housing..

HOW TO TEAR DOWN

The instrument should be "torn down" in the following manner for servicing.

1. Remove the two screws from the bottom of the cabinet.

2. Holding the cabinet with one hand and pulling on the handle with the other will remove the top section and chassis (which is attached to the top).

3. The top piece may be folded to one side to facilitate working on the circuit. This is done by removing the two screws that hold the circuit shelf. The top can then be rotated on the rivets to a position which exposes the circuit for examination.

In reassembling the instrument, care must be taken in lining up the top of the instrument with the groove in the top of the cabinet. Uniform pressure should be applied to the top to bring the bottom section evenly to the rubber seal. If the seal is not completely contacted, the cabinet is no longer waterproof.

BATTERY REPLACEMENT

1. BE CAREFUL - the high voltage batteries can give a shock which may be lethal.

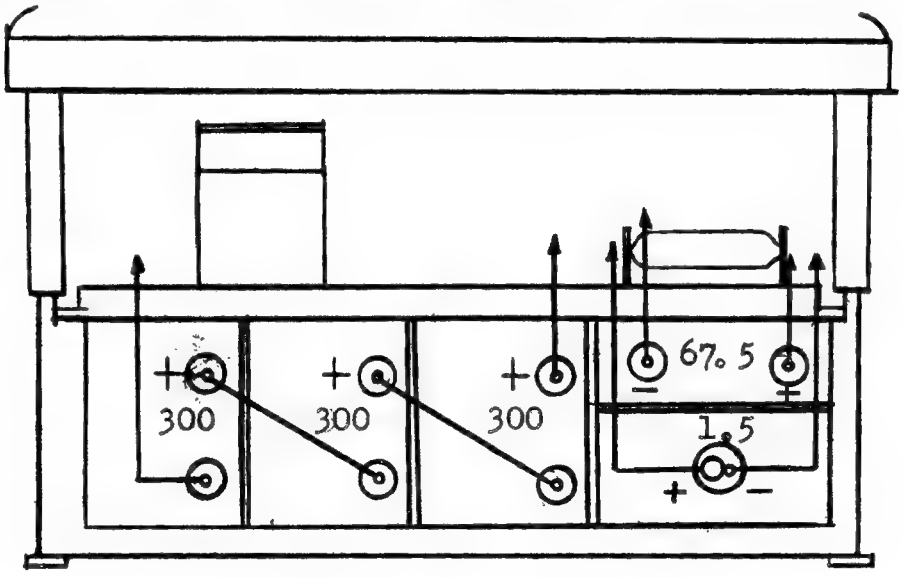
2. Turn the range selector switch to the OFF position. Remove the negative and positive leads from the high voltage batteries and disconnect the jumpers between the batteries.

3. If the low voltage batteries are to be replaced, their leads must be disconnected. The 67.5 volt battery has snap-type connections which are easily removed with a screwdriver or sharp-pointed instrument.

4. Remove the two screws that hold the center shelf. Tilt back the shelf and remove the batteries.

5. Replace the batteries as shown below. The low voltage batteries should be replaced first. Then insert the two end high voltage batteries and slide the center high voltage battery in position.

6. Replace the battery leads and jumper connections.



Battery Replacement and Wiring

SECTION V

TROUBLE SHOOTING

GENERAL

A visual inspection will often help in determining the cause of improper operation of the instrument. Listed below are some of the defects that may be found:

1. Loose screws and nuts.

2. Broken solder connections.

3. Damaged Insulation.

4. Pitted or dirty switch contacts.

5. Burned or broken resistors.

6. Exposed wiring, causing shorts with wiring, terminals, or ground.

7. Corroded or swollen batteries.

The following notes are given to aid in the diagnosis and repair of any failures not due to any of the above defects. The steps are given in the order in which they should be tried. If the first step does not locate the trouble, proceed to the second, etc.

NO METER INDICATION OF BACKGROUND OR OTHER RADIATION

1. Check high voltage batteries and plateau of Geiger counter to see if the counter is being operated in the plateau region. The ordinary life of the self-quenching organic vapor Geiger counter is about 10^8 counts. The counter should have a threshold voltage of from 800 to 825 volts when new. As the batteries age, the voltage will decrease. The high voltage should be at least 25 volts and not more than 200 volts above the threshold voltage of the Geiger tube.

2. Check the operation of the circuit with a pulse generator fed into the input grid circuit (see page 9). The circuit should trigger and give a meter indication with a 0.5 to 1.0 volt negative pulse.

3. Check circuit batteries and voltages.

4. Replace tubes.

ABNORMALLY HIGH METER READING WHEN NOT IN RADIATION FLUX

1. Put probe with counter in complete darkness. If meter reading

falls to the background value, the Geiger tube is photosensitive. Paint the tube with black glyptol or cover with black paper.

2. Remove the GM tube from the probe. If the meter no longer indicates, the counter was probably in continuous discharge and must be replaced.

3. Circuit may be oscillating. This can be detected in the headphones. Replace the tubes.

4. VT-2 may not be properly cut-off and thus may be drawing plate current with no signal. Replace VT-2.

5. VT-1 may have an open filament and thus not draw plate current necessary to bias VT-2 to cut-off. Replace VT-1.

6. Check voltages and test for shorted or open circuits.

ERRATIC METER MOVEMENT

1. If the meter needle moves to full scale and then starts to come down to zero again when brought into a more intense radiation field, the high voltage may be too low. If the high voltage is not enough above the threshold voltage at high radiation intensities, the output pulses will become too small to trigger the circuit. Normally, an instrument will not exhibit such symptoms unless the radiation intensity exceeds 2 to 20 r/hr (100 to 1000 times full scale on the least sensitive range). At this intensity, the Geiger counter becomes paralyzed.

2. Check operation of the circuit with a pulse generator. The circuit should trigger and give a meter indication with a 0.5 to 1.0 volt negative pulse fed into the input grid circuit (see page 9).

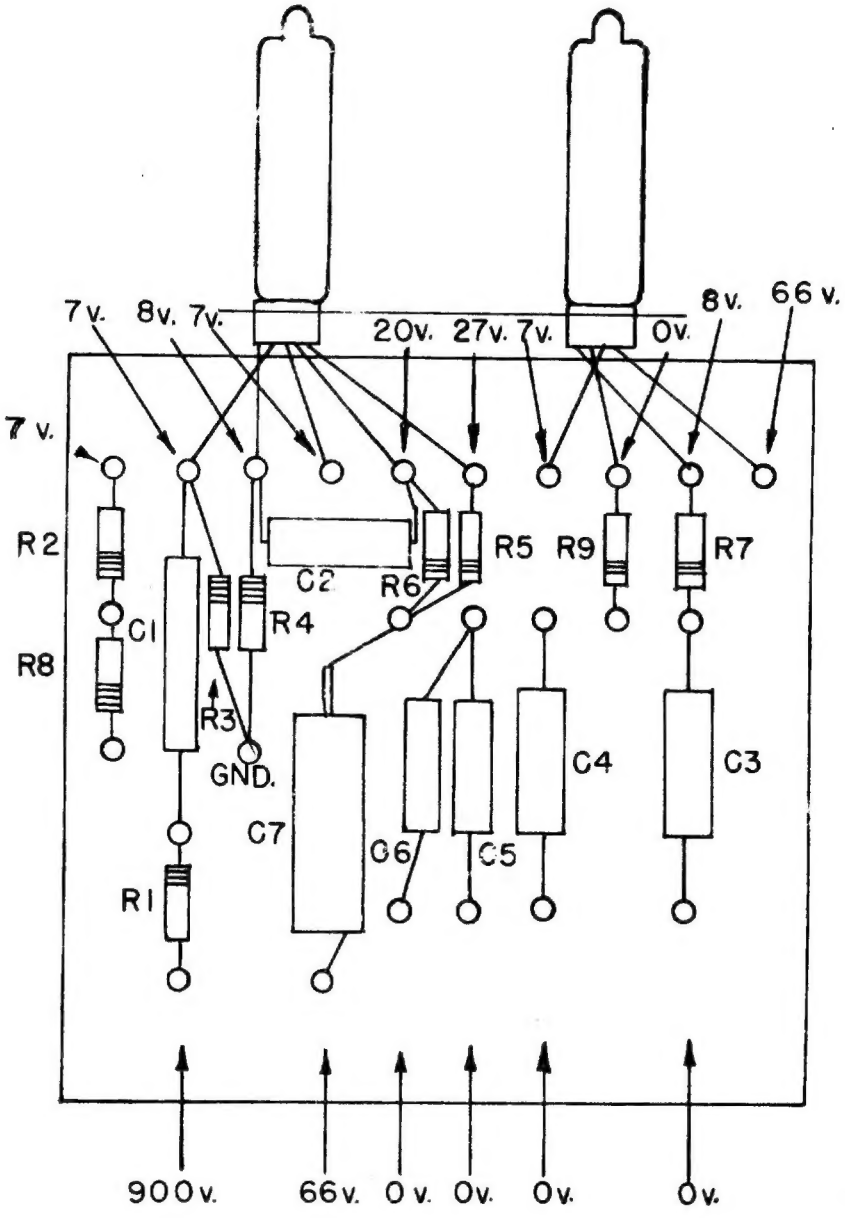
3. Check low voltage batteries and circuit voltages.

4. Replace tubes.

VOLTAGE MEASUREMENTS

A voltmeter of at least 5 megohms input resistance should be used for measuring circuit voltages. The voltages given on the circuit diagram (rear of this manual) and on the terminal board diagram (opposite page) were measured with new batteries. The voltages, excluding high voltage for the Geiger counter tube, may vary by as much as 15% to 20% without affecting circuit operation (except for calibration).

All voltages were measured with respect to ground.



Voltages to chassis measured on voltmeter with total resistance of 5 megohms.

SECTION VI

PARTS LIST

BATTERIES

			NUCLEAR PART NO.
B1	1.5 volt	Burgess 2F	BA003
B2	67.5 volt	Eveready 467	BA005
B3	300 volt (3 required)	Eveready 493	BA006

RESISTORS

All resistors are Allen-Bradley, ½ watt, 10% fixed composition type unless otherwise indicated.

R1	2.2 M		RC20AE225K
R2	2.7 M		RC20AE275K
R3	330 K		RC20AE334K
R4	33 K		RC20AE333K
R5	200 K		RC20AE204K
R6	1.2 M		RC20AE125K
R7	150 K		RC20AE154K
R8	33 K		RC20AE333K
R9	200 K		RC20AE204K
R10	500 K	2 Watt Potentiometer	RV030

CAPACITORS

C1	270 mmfd	1600 V	Mica		CM003
C2	.01 mfd	300 V	Mica	20%	CM35A103M
C3	.005 mfd	500 V	Mica	20%	CM35A502M
C4	.005 mfd	500 V	Silver Mica	2%	CM35C502G
C5	450 mmfd	500 V	Silver Mica	2%	CM35C451G
C6	33 mmfd	500 V	Silver Mica	2%	CM20C330G
C7	50 mfd	6 V	Electrolytic		CE008

TUBES

VT1	CK522	Raytheon	VTCK522AX
VT2	CK522	Raytheon	VTCK522AX
GM	CK1020 (D50)	Raytheon	VT-010

MISCELLANEOUS

Meter 0-20 milliamps (waterproof)	Simpson 185	MP003
Selector Switch	Centralab 2CHW11486	SW-011
46½-in. Probe Cable	Amphenol RG59U	CA-001
Radioactive Source	Nuclear R2	RA-001
Probe Assembly	Nuclear	PR-005
Phones (double headset)	Brush 200A	PH-001

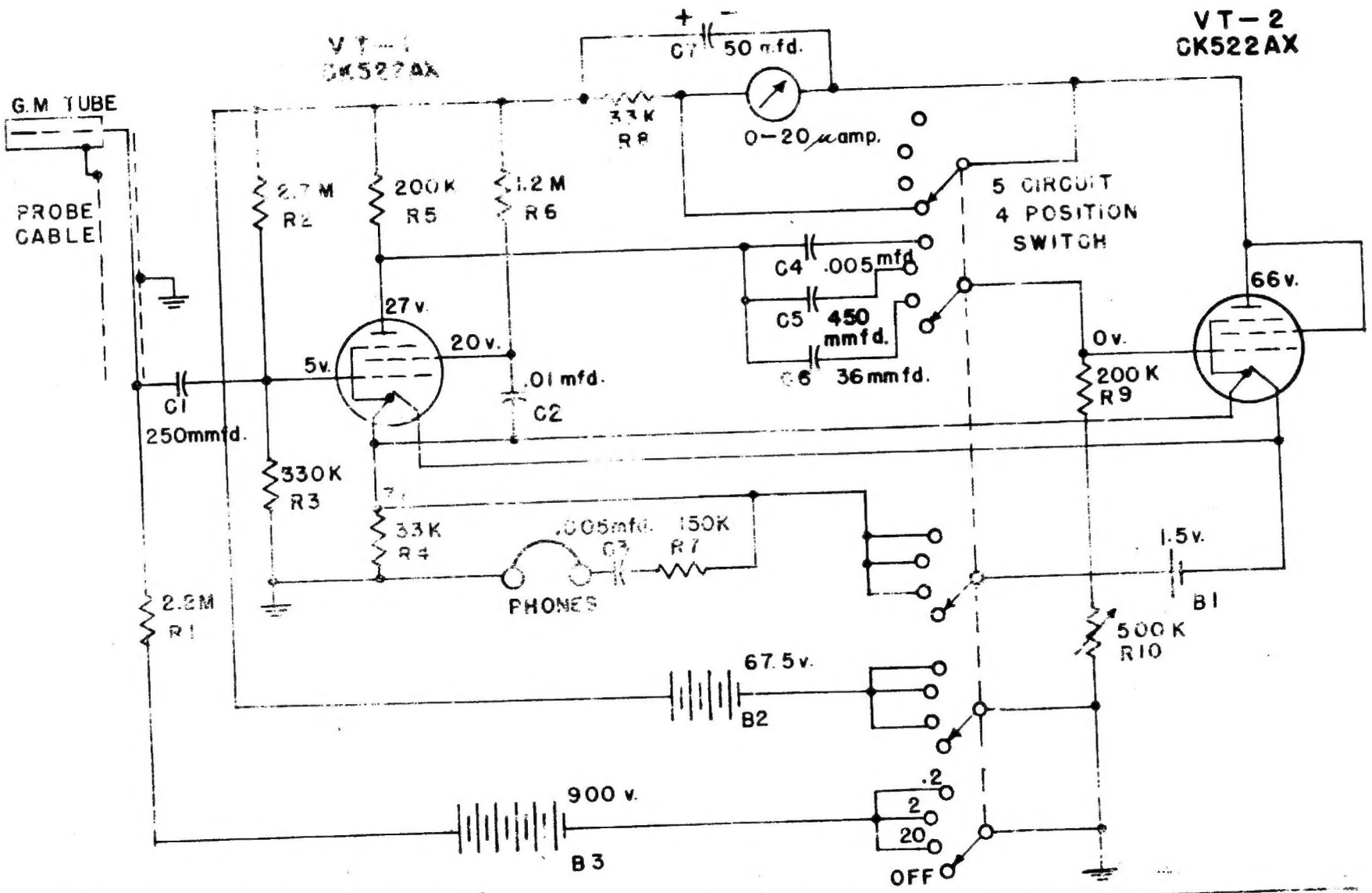
		NUCLEAR PART NO.
B1 Battery Plug	Cinch 2744	PL-002
B2 Battery Connectors	United Carr 52383	CO-023
	United Carr 52384	CO-024
3 Black Battery Plugs (for B3)	Amphenol 71-1M	PL-006
3 Red Battery Plugs (for B3)	Amphenol 71-1L	PL-007
Midget Phone Jack	Switchcraft 2J1065	JA-002
2 Phone Jack Covers	Croname A23559	JA-005
Phone Plug	Switchcraft 2P-1020	PL-004
Female Connector (GM Socket)	Amphenol 91MPF-3S	CO-012
2 Socket Nuts (for above)	Amphenol 91MC-3F	CG-002
2 Tube Sockets (5 pin min.)	Cinch 54A11953	SO-006
2 Retainer Rings (for above)	Cinch 20K12446	CL-016
Tube Holder	Nuclear	BC-024
2 Rubber "O" Rings for #10 screw	Lavelle	GR-007
"O" Ring-21/32 ID x 29/32 OD x 7/16	Lavelle	GR-008
2 ½" Rubber Grommets	Lavelle	GR-004
2 "O" Rings 3/8 OD x 1/4 ID x 1/16	Lavelle	GR-009
Handle, with Probe Holder	Nuclear	HA-005
Plastic Battery Insulator	Nuclear	IN-040
Selector Switch Knob	H.Davies 2110AZ	KN-015
Potentiometer Bracket	Nuclear	BC-023
2 Self-tap screws 10-32 Slotted, ½" Cad. Plated		SC-010
3 ft. Fungus Resistant Waxed Cable Cord		TW-001

SUGGESTED MAINTENANCE KIT OF PARTS FOR FIVE INSTRUMENTS, FOR ONE YEAR

2 Vacuum Tubes	Raytheon CK522	VTCK522AX
5 Geiger Counter Tubes	Raytheon CK1020	VT-010
2 GM Tube Sockets	Amphenol 91MPF3S	CO-012
2 Socket Housing Nuts	Amphenol 91MC-3F	CG-002
2 Capacitors, 50 mfd, 6 V, Electrolytic		CE-008
2 Capacitors, 270 mmfd, 1600 V, Mica		CM-003
2 Phone Jack Covers	Croname A23559	JA-005
1 Switch - wafer, 6 circuit, 4 position		SW-011
1 Meter, 0-20 ma (waterproof)	Simpson 185	MP-003
4 Screws, 10-32 Slotted, self-tapping		SC-010
10 rubber "O" Rings, 3/8 OD x 1/4 ID x 1/16		GR-009
5 Rubber "O" Rings, 21/32 ID x 29/32 OD x 7/16		GR-008

NOTE

Since battery replacements depend upon rate of usage as well as shelf life, no general recommendations can be made for spares.



NOTE — Voltages to chassis, measured on voltmeter with total resistance of 5 megohms.

DRAWN C.O.S.	MODEL 261OA
CHECKED E.L.C.	PORTABLE BETA-GAMMA SURVEY METER
APPROVED	NUCLEAR INSTRUMENT & CHEMICAL CORP. CHICAGO, ILLINOIS